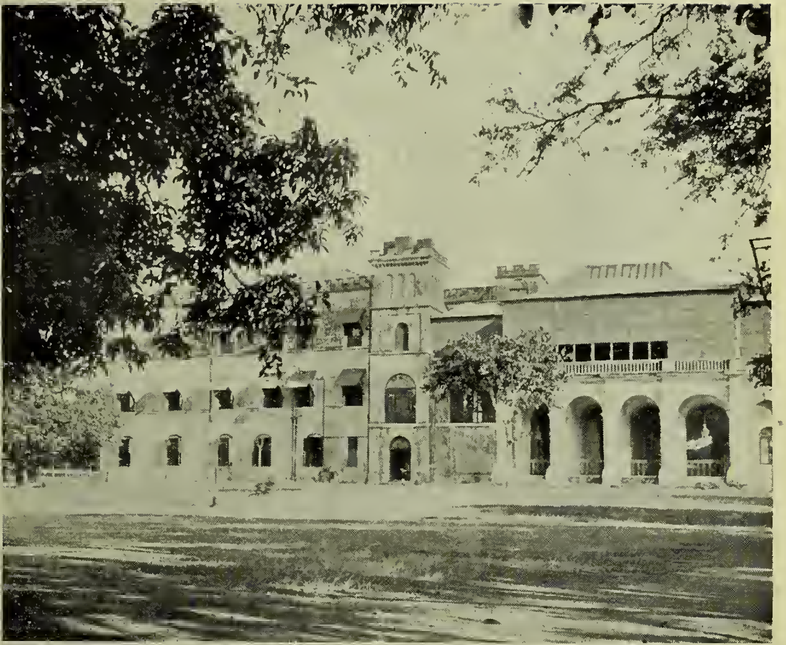
THE BOMBAY
Bacteriological Laboratory.

THE PREPARATION AND USE
OF
ANTI-PLAGUE VACCINE.



The Bombay Bacteriological Laboratory.

Plate I.

A Group of Villagers being inoculated.

PLATE II.

THE BOMBAY

BACTERIOLOGICAL LABORATORY.

THE PREPARATION AND USE
OF
ANTI-PLAGUE VACCINE.

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Introduction.

THE Bombay Bacteriological Laboratory has had a short, though eventful, history. Originally started by Mr. Haffkine, the discoverer of anti-plague vaccine, on the 8th October 1896, a fortnight after plague had been officially declared to exist in Bombay the Laboratory has grown from a small institution to one of considerable dimensions. For long the Laboratory was known as the Plague Research Laboratory, but recently the name has been changed to the Bombay Bacteriological Laboratory, thus indicating the wider field of investigation and research which is now undertaken at this institution. While the Laboratory functions as a general research institute for the Bombay Presidency, plague research still remains its chief duty. Nor has the Laboratory played an unimportant part in the progress of our knowledge of plague. Mr. Haffkine here first elaborated and prepared his wonderful "Plague Prophylactic," which has saved the lives of many thousands of human beings. Here, too, more recently the epoch-making discoveries in connection with the ætiology of plague were made by a Commission working on the facts and materials which had been accumulated after ten years of patient labour on the part of the staff of the Laboratory. These discoveries have given to sanitarians and administrators a firm foundation on which to build their schemes for combating and preventing the spread of plague. It is pleasing to know that while India has been sorely smitten by this fell disease, she has been the leader in advancing our knowledge of its cause and prevention, and that the Bombay Bacteriological Laboratory has played no small part in assisting her to attain this position.

This pamphlet has been prepared for the use of those who are called upon to carry out measures for preventing the spread of plague in India. It has been written, as will be understood from what has been said above, after a prolonged and extensive experience of the disease now extending over ten years, the facts which it details, therefore, are put forward with some authority.

Some facts which should be kept in mind when determining what Anti-Plague Measures to adopt.

Plague may be defined as a rat disease ; not infrequently, under favourable circumstances, it is communicated to man, generally by rat fleas. The disease among men might almost be said to be accidental, and certainly avoidable, if there were a distance between rats and men. The association of men with rats is dependent partly on the mode of living of the former and partly on the habits of the latter. If rats could be got rid of, there would be no plague ; but if this is impossible, we have only two alternatives, —either to flee from the disease or to acquire protection against it by being inoculated with Haffkine's vaccine.

Anti-plague measures are of two kinds : (1) measures of permanent utility and (2) measures of temporary utility.

(1) Measures of permanent utility are directed against those habits of rats and men which bring about the association of the one with the other. They deal with the erection of well-built houses, the separation of shops, warehouses, granaries, and stables from human habitations ; the construction of concrete floors and roofs of materials which cannot harbour rats. These measures affect the habits of rats. Measures which are directed to improve the habits of men are such as teach him to live in a tidy manner, which prevent him from throwing waste food material out of the window of his dwelling or placing it in any other place where it may be reached by rats. All these are measures of permanent utility in the fight against plague, but unfortunately such measures will take many years to carry out to completion ; nevertheless, in the meantime, they should not be neglected.

(2) Measures of temporary utility can be grouped under the following three heads :—(*a*) Measures for protecting the people in their homes from rats and their parasites ; such measures can be classed under the term ' Rat destruction.' (*b*) Measures for

removing the people from their homes in order that they may avoid infection from rats and their parasites, measures which are recognised under the term ' Evacuation.' (*c*) Measures rendering the individual largely immune from attack and death from plague, measures classed under the term ' Inoculation.'

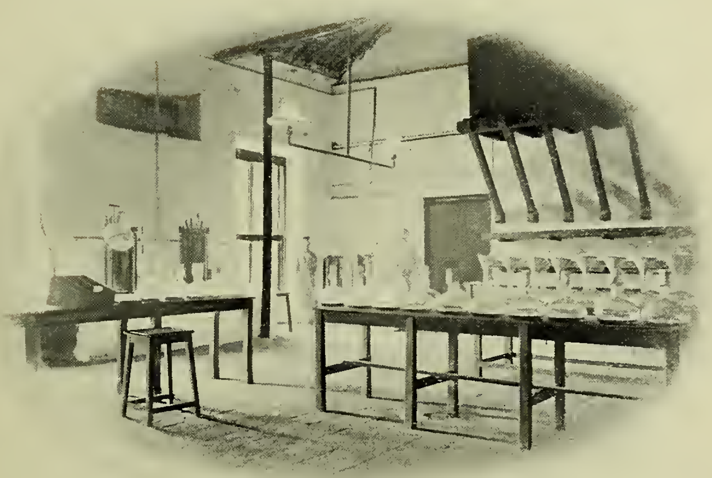
Let us consider for a moment the advantages and disadvantages of each of these measures for dealing with plague. In the first place it should be noted that all these measures require to be carried out repeatedly ; they are only temporary measures. In this respect rat destruction and evacuation possess no advantage over inoculation. While, however, the first two measures can be carried out by the people themselves, the latter requires the employment of a special staff.

(*a*) But to take each measure separately, let us consider first the advantages of rat destruction. Undoubtedly, if there were no rats there would be no plague. This measure strikes at the root of the evil, and has the great advantage that it interferes little with human comfort. Indians who have experienced a temporary freedom from rats have recognised the advantages of living without these pests, their absence insures less disturbance at night and less injury and loss of property. The disadvantage of rat destruction lies in the fact that to be successful this measure must have the complete co-operation of an entire community and the operations must be extensive and sustained. The poisoning of rats either by the use of chemical poisons or by the dissemination of bacterial disease among them has not proved as successful as was anticipated. No more efficient rat destroyer than plague itself has yet been discovered. The failure to keep down rats by poisoning them arises from the fact that the operations have, as a rule, only been temporarily carried out and can never be persistently maintained except at great cost. Trapping rats alive and then destroying them has yielded better results when daily practised. At least one trap for every 50 inhabitants in a town or village should be set every day. The rat infestation of Indian towns and villages is enormous. Rats are so prolific that it is possible to remove from a village, within a period of one year, a larger number of them than the total human population of the place without materially affecting the number of rats remaining alive in the village. In a village of, say, 2,000 inhabitants nothing less than 2,500 rats should be captured and destroyed within a period of one year if it is desired to effect a check on the spread of plague.

The removal of any smaller number will do more harm than good, for, by removing adult immune rats which have survived from previous epidemics and permitting their replacement by young susceptible rats, the disease among these animals will be more extensive and virulent, so that the epidemic among men will be proportionately more severe.

(*b*) Evacuation to be effective must be carried out early and completely. It is generally useless to vacate a house after a death from plague has occurred in it. Even when evacuation is not practised, only 20 to 30 % of houses yield more than one case. In towns, especially, it must be remembered that infection is frequently not acquired at home but in the workshop, office, or other place of resort. The greatest disadvantage of evacuation, however, arises from the increased chances of spreading the disease. Many prefer to go to live with friends in uninfected villages rather than submit to the discomforts of camp life. Infection is thus distributed, for man is an important carrier of the infection. Evacuation too tends to increase the panic produced by the high mortality associated with the disease.

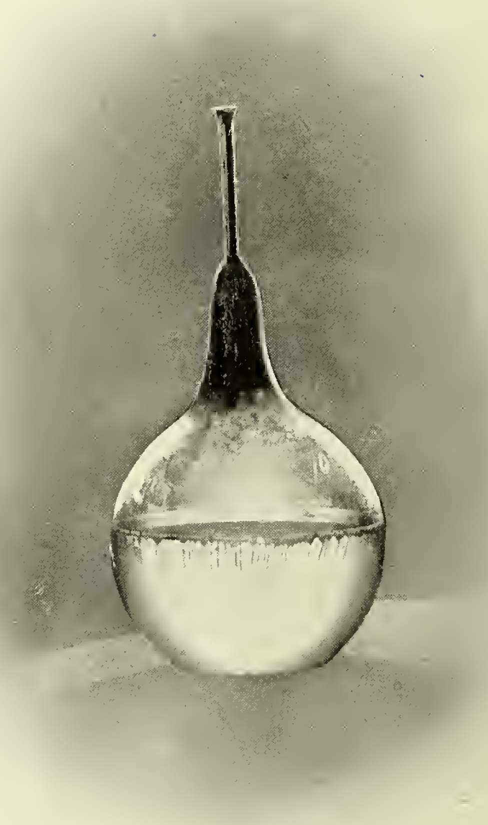
(*c*) The advantage of inoculation lies in the fact that it is a measure of personal prophylaxis. It matters little who else does or does not co-operate in the measure, those inoculated at least are safe. It is a measure which can be easily and cheaply carried out once a year. A guarantee can be given that at least six times the saving of life will be effected among the inoculated as compared with the uninoculated. When inoculation is more extensively adopted, an even greater saving of life may be obtained. Every case which is saved from the disease affords many less opportunities for the disease being imported into fresh localities by friends who would have come from other towns and villages to attend the funeral ceremonies. Moreover, inoculation instils into those who undergo the operation that confidence which is so necessary in averting a panic. When the majority in a village are inoculated, the epidemic assumes such moderate proportions that it can be dealt with easily and it is possible to adopt measures to prevent the spread of infection to adjoining areas. Inoculation checks the spread of plague, directly by lessening the number of attacks and reducing the mortality from the disease, and indirectly by quelling panic and thus reducing the chances of importing the disease into uninfected places.



The Kitchen in which the "Broth" is prepared.

PLATE III.

Medicine



Haffkine's Stalactites.

PLATE IV.

What may be effected by Inoculation with Anti-Plague Vaccine.

Like vaccination against small-pox, inoculation reduces the chances of plague attack in the inoculated ; and those who are attacked recover more frequently and more easily if they have been inoculated previously.

During an epidemic there are about three times fewer attacks of plague in the inoculated ; and among plague patients the number of deaths in those who have undergone inoculation, is about half as compared with the mortality amongst the uninoculated patients. The final result is that during the prevalence of plague the number of deaths in the inoculated is about one-sixth that amongst the uninoculated living in the same infected locality.

For instance, in a village of 4,000 inhabitants where plague was sufficiently virulent to attack three persons in every hundred of the inhabitants, and where half the population had been inoculated, we would expect to find the 2,000 uninoculated people yielding about 60 cases with 45 deaths, while the 2,000 inoculated would have some 20 cases with 7 deaths.

Better results than these are secured when a proportion of the people greater than one-half is inoculated ; and if all are operated on, the epidemic assumes trifling proportions, is easily dealt with and creates no panic.

The following examples of the benefit accruing from inoculation in a community which has been attacked by plague have not been selected as illustrating the best results obtained by this measure but because of the thoroughness with which the inquiry was conducted after the disease had subsided and because of the carefully kept records which were available in each instance.

The first example offers an illustration of the number of lives that may be saved in a village community.

Experience in Villages.

A very virulent epidemic of plague was raging in the village of Undhera in the Baroda State. The village was visited and a nominal roll of the inhabitants then living in each household was made and as near as possible one half of the inhabitants in each household were inoculated. It was found that there were 950 persons then alive in the village and of these 513 were there and then inoculated. No selection was made as to who was or was not to be inoculated other than that required to make the two groups of inoculated and uninoculated as comparable as possible in regard to age, sex and physical fitness. Plague continued in the village for 42 days after the inoculations were performed and affected 28 families. These families were composed of 71 inoculated and 64 not inoculated persons. The 71 inoculated had 8 attacks with 3 deaths, while the 64 not inoculated had 27 attacks with 26 deaths. If the inoculated had suffered to the same extent as their uninoculated relatives, they should have had 29 deaths instead of 3 only.

Colonel Bannerman, who with others investigated the results of this experiment, writes : "I myself carried the census lists, and from it called out the inhabitants of the plague-infected houses by name, and I shall never forget the experiences of that day. One incident I particularly remember, the finding in two huts in succession that all the uninoculated had died and that only the inoculated members of the household came out to answer to their names. The attitude of the people was also very striking, for, when asked about the results of the experiment, they said that 'about fifty uninoculated had been attacked and they are all dead, while only a few inoculated have been ill, and they have all recovered.'"

Further details of this very carefully conducted experiment will be found in a pamphlet entitled "The Plague Prophylactic," by Colonel Bannerman, I.M.S., and printed at Government Central Press, Bombay. Price 3 Annas.

The following table compiled by Major E. Wilkinson, I.M.S., late Chief Plague Medical Officer in the Punjab, is of interest in this connection. The figures refer to all villages where 10 per cent. or more of the inhabitants had been inoculated and where plague was present or subsequently appeared not later than four months afterwards.

	Population.	Attacks.	Deaths.	Case-incidence per cent.	Case-mortality per cent.
Inoculated...	186,797	3,399	814	1·8	23·9
Not inoculated ...	639,630	49,433	29,723	7·7	60·1

By a simple calculation one can readily estimate that in these villages inoculation saved some eight thousand lives.

Experience in Towns.

The next example selected illustrates what saving of life can be effected in a town. The figures refer to a single chall or large building in Bombay City known as No. 201 Cattle Lines, Pilot Bundar. In this chall there lived 61 persons in ten rooms. The rooms were separated from one another by 10-foot partitions, but the roof space was common to all the rooms. Inoculations had been done among the people of this neighbourhood two months previous to the outbreak of plague in the chall. When the epidemic was over, an investigation was made and all the inhabitants of the chall traced with the exception of four. Only one of these four had been inoculated and it was reported that none of them had been attacked by plague. The result was found to be as follows :—24 inoculated persons had among them 1 attack and no death ; while 37 not inoculated had 19 attacks with 12 deaths. If the inoculated had suffered to the same extent as those not inoculated, they should have had 12 cases with 8 deaths, instead of 1 case which recovered.

Fuller details of this experience will be found in the above mentioned pamphlet " The Plague Prophylactic " by Colonel Bannerman.

In No. 1 Division of Bombay City, the Municipal labourers are housed in challs owned by the Municipality. In 1905 and 1906 a large number of these Municipal servants and their families were inoculated. The result of the inoculations was carefully observed and investigated by Dr. Turner, the Health Officer, and his subordinates.

The following table shows the events among the inhabitants of the Municipal challs :—

	Population.	Plague Deaths.	Percentage of Deaths.
Inoculated ..	3,317	3	0·09
Uninoculated	836	18	2·1

If the 3,317 inoculated had suffered to the same extent as the 838 uninoculated, they ought to have had 71 deaths instead of 3 only.

The following shows the occurrences in two challs in which the Health Officer says "the greatest number of plague deaths occurred":—

	Population.	Plague Deaths.	Percentage of Deaths.
Inoculated ...	376	Nil	Nil
Uninoculated	165	11	6·6

If the 376 inoculated had suffered to the same extent as the 165 uninoculated, they ought to have had 25 deaths, whereas they had none.

The above example illustrates what can be done by a Municipality to save the lives of their employés. The experience of Bombay is not unique in this respect.

Experience of Public Employers of Labour.

In Karachi the Health Officer of that city inoculated a large number of the menial staff of the Municipality with the following results:—

	Population	Cases.	Deaths.	% of Cases to Population.	% of Deaths to Population.	Case Mortality.
Inoculated ...	1,245	22	4	1·76	0·32	18·18
Uninoculated.	60	8	5	13·33	8·33	62·50

Experience of Private Employers of Labour.

Private employers of labour have had a similar experience of inoculation. By having their employés inoculated, great saving in time, labour and worry was effected during the prevalence of plague. Thus Mr. Bazonji Dadabhoy, the manager of the Empress Mills, Nagpur, found that of 1,116 mill-hands who were inoculated, only six died of plague, whereas 2,663 uninoculated mill-hands had 179 deaths from that disease.

Experience of Railway Companies.

The advantages of inoculation have been demonstrated to Railway Companies in a crucial experiment carried out among the employés of the Southern Mahratta Railway Company in 1896. The men and their families lived in the Railway challs, some little distance from the town of Hubli. They were carefully kept under observation. Among 1,260 who were inoculated 11 cases and 2 deaths occurred, whereas among 760 who were not inoculated 35 attacks and 21 deaths occurred, so that although the uninoculated were about two-thirds less numerous than the inoculated, yet they had three times as many attacks and ten times as many deaths from the disease. For particulars of this experiment see report of the Hon. E. L. Cappel, Esq., Collector of Dharwar, published by Government, No. 3569 of 1898.

Experience of Military Authorities.

Military and Police Officers have learned that inoculation can save many lives in the presence of plague.

For example, Major G. S. Thomson, I.M.S., who was in charge of the 114th Mahrattas, reported in 1906 that the whole of the 114th Infantry including families and followers were inoculated making a total of 1,155 individuals. Only 1 man of this number suffered from plague ; he had a mild attack and recovered. Now about 700 yards distant, the 121st Pioneers were living in exactly similar circumstances and surroundings, but they were not inoculated at the time when plague broke out. They had 13 attacks and 13 deaths, when inoculation was resorted to, to check the disease. Three attacks and two deaths occurred within 3 days after the inoculations were completed and these cases closed the epidemic.

Experience among the Police.

In 1905, 1,598 policemen were inoculated in the Khandesh district, and of these only 3 died of plague, while of 230 who remained uninoculated, 4 died of the disease. If the inoculated policemen had been exposed to plague to the same extent as the uninoculated policemen and if they had not been protected by inoculation, they would have had 26 deaths in place of 3 only.

Experience of the Jails.

Jail authorities have found that inoculation is the best way to combat the plague.

Major Jackson, I. M. S., Acting Inspector-General of Prisons, Bombay Presidency, writing to the *Times of India* of 25th September 1905, gives his experience somewhat as follows :—

" In the early years of plague prevalence, strict segregation and disinfection of all arrivals and their clothing with isolation of every suspicious case of fever were resorted to. It was under these circumstances that inoculation came to be the resource of the Jail authorities who were harassed by the endless labour (attending measures of isolation, &c.) and beaten in the strife with plague, and who found that inoculation is as successful as the most rigorous segregation, evacuation and disinfection and very much less troublesome to everyone concerned." From figures he showed that " as inoculation has been more and more resorted to in the prisons, so the incidence of plague and death-rate has diminished." Thus in 1897 with a daily average population of 8,392, there were 48 cases of, and 27 deaths from, plague, while in 1904, with an average population of 8,166, there were only 8 cases with 5 deaths from that disease. In fact, as Major Jackson observes, plague has been banished from the prisons, and in importance has " sunk to the level of measles."

A Popular Account of the Mechanism by which Anti-Plague Vaccine effects a Saving of Life in the Presence of Plague.

All are familiar with the fact that persons seldom suffer from two attacks of certain diseases, such as small-pox, typhoid fever and plague. One attack of the disease protects the patient from another attack of the same disease : nevertheless, the protection so acquired is not absolute ; some people have suffered from small-pox or typhoid or plague on more than one occasion, but such cases are very infrequent.

Dr. Jenner was the first to show that protection from small-pox could be acquired by inoculating a person with a modified form of the disease known as cow-pox. This cow-pox was cultivated by him, and he injected persons with it, who were thereby protected from small-pox. The material he used is derived from the cow which in Latin is called *vacca*, hence Jenner's prophylactic for small-pox came to be known as vaccine. The vaccine for small-pox used by Jenner and others is a living organism which when placed upon the abraded surface of the skin can grow and multiply and penetrate beneath the skin into the blood, and so bring about changes in the living cells of the body which ultimately protect the person from small-pox.

It was soon found in connection with other diseases as typhoid fever and plague that a living vaccine was not necessary to bring about those changes in the body of a person which ultimately protect him from a particular disease, provided only that the products of the life of the organism which produce the disease are injected under the skin, so that they may enter the blood and reach the living cells of the body. The vaccine having gained an entrance to the blood, and having come in contact with the living cells of the body, stirs them up to produce an antidote to the poison of the disease, and protection from the disease is thereby effected.

With the discovery that dead vaccines could be effectively used to protect a person from a particular disease, a large number of vaccines were prepared for a variety of diseases, and it became necessary to distinguish one vaccine from another. This was effected by applying to the word vaccine the name of the disease against which each particular vaccine protected. Hence nowadays you hear of small-pox vaccine, anti-typhoid vaccine and anti-plague vaccine. It is with this latter anti-plague vaccine that we are concerned.

Inasmuch as the small-pox vaccine is a living vaccine, and is only placed on the surface of the abraded skin to ultimately multiply and penetrate into the blood, the term vaccination was applied and confined to this method of administering and using a living vaccine. But since a dead vaccine like the anti-typhoid and anti-plague vaccine requires to be injected under the skin to enter the blood stream, the term 'inoculation' has been applied to this method of administering a dead vaccine.

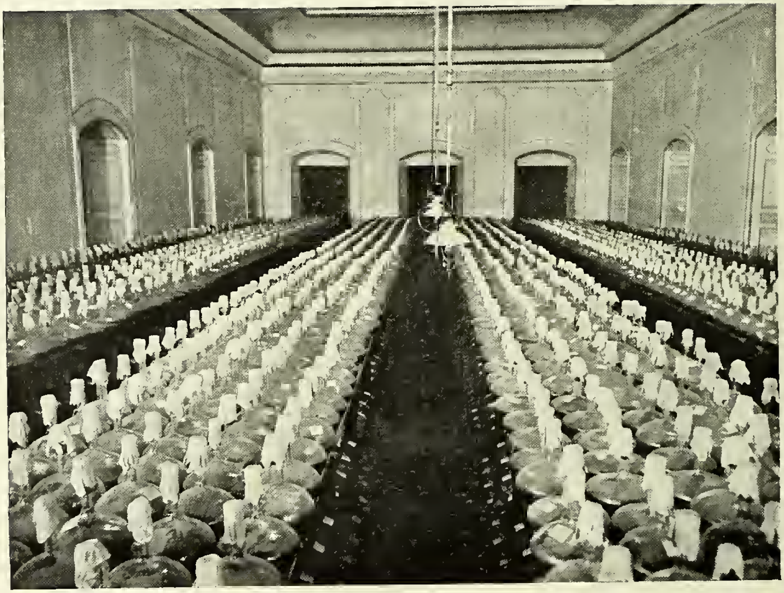
Vaccines have recently been used not only to protect persons before they acquire the disease, *i.e.*, used as prophylactic agents, but they have been used also as curative agents after the person has actually been attacked by the disease. The first person to use a vaccine in this way was Pasteur, whose famous treatment of Hydrophobia or Rabies is simply a treatment with anti-rabies vaccine. Sir Almroth Wright has devoted much study to this subject and has successfully used vaccines in the treatment of many diseases and has given the name Vaccine Therapy to this branch of modern medicine. It will now be possible to consider and answer certain questions frequently asked by those who are about to be inoculated.

Should Anti-Plague Inoculation be carried out in the Presence of the Disease? Will any Harm be done to those who have actually acquired Infection, although at the Time of Inoculation they show no Signs of the Disease?

Some will confront us with the *a priori* objection that it is plainly irrational to expect anything but harm to accrue from

The Sowing and Testing Room.

PLATE V.



The Incubating Room.

PLATE VI.

the injection of bacteria and their toxines into a person who is already infected with the living bacteria which are, of course, constantly producing their poisons. It is possible to answer such critics in two ways ; on the one hand, they may be confronted with the favourable results of actual experiments which disprove their *a priori* assumption and, on the other hand, it would be possible to direct their attention to certain facts which a closer study of Vaccine Therapy has revealed, which show that the use of vaccine in septicæmic conditions is not the irrational procedure that it might at first sight appear. To refute the critics in this latter way would entail a familiarity with technical terms with which the majority of the readers of this pamphlet are unfamiliar, and it will therefore be necessary to confine attention to detailing the results of experiments which disprove the assumption that harm is done when a person is inoculated with anti-plague vaccine while he is incubating the disease.

It has already been pointed out that vaccines have been used with success in curing persons suffering from certain diseases, and Pasteur's method of treating Hydrophobia was instanced. Sir Almroth Wright has obtained "in very numerous cases conclusive evidence of an augmentation of the opsonic power of the blood within an hour after the inoculation of tubercle vaccine, and also trustworthy witness of associated clinical improvement within that time in connection with the inoculation of tubercle vaccine in an infection of the eye."[1] Sir Almroth Wright's experience with tubercle vaccine is in conformity with the experience obtained in India in connection with the use of anti-plague vaccine. Inoculations with anti-plague vaccine have been carried out on a large scale in various parts of India, hundreds of thousands of persons having been operated upon. It has been found possible to compile the following table from the reports sent in from certain prisons and small villages where accurate statistics have been kept, showing the case-mortality in persons inoculated during the incubation period of plague.

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[1] *Lancet*, August 24, 1907, p. 493.

	Attacks.	Deaths.	Case-mortality per cent.
Cases which had plague actually evident at time of inoculation, or which developed it the same day	43	21	48·8
Cases which developed plague on first day after inoculation	40	23	57·5
,, ,, 2nd day	40	22	55·0
,, ,, 3rd ,,	38	21	55·3
,, ,, 4th ,,	27	10	37·0
,, ,, 5th ,,	37	18	48·6
,, ,, 6th ,,	26	10	38·5
,, ,, 7th ,,	29	14	48 3
,, ,, 8th ,,	24	9	37·5
,, ,, 9th ,,	24	15	62·5
,, ,, 10th ,,	30	9	30·0
Total within the first ten days after inoculation...	358	172	48·04
Cases which developed plague subsequently	566	230	40·6
Total plague cases among the inoculated	924	402	43·5
Total plague cases among the uninoculated portion of the population during the same epidemics...	5,079	3,726	73·3

We have here records of over 6,000 attacks of plague, with a case-mortality in the inoculated of 43·5 per cent. and in the uninoculated of 73 3 per cent.

These figures show that on no occasion did the case-mortality of the inoculated even approach the figure obtained among the uninoculated, namely, 73·3 per cent. Moreover those who had symptoms of plague at the time of inoculation, or developed them the same day, had a case-mortality of only 48·8 per cent. which is considerably lower than that found among the uninoculated. We conclude that no harm will be done by inoculating persons in the midst of plague infection, provided the dose of the anti-plague vaccine used does not exceed that prescribed on the bottles sent out from this Laboratory.

How long does the Protection conferred by Inoculation with Anti-plague Vaccine last?

To answer this question satisfactorily, some knowledge of the problems of immunity is necessary, but the following explanation may suffice for the present.

The amount of protection conferred on an individual by inoculation depends on (*a*) the dose of vaccine used ; (*b*) the power the individual has of reacting to a certain dose of vaccine ; (*c*) the circumstances in which the individual is found at the time when he is subjected to infection ; (*d*) the dose of the infection which he receives. With such a number of varying factors affecting the degree of immunity conferred by inoculation, it is impossible to lay down the exact period for which protection lasts. Some statistics are available, however, to show that, while protection is most marked during the six months immediately following inoculation, immunity is still marked at the end of one year, and the degree of protection remaining during the second year after inoculation is only slightly less than that of the first year, and even after five years some trace of protection remains. While this is so, it is very desirable that persons should be inoculated during each successive plague season so as to acquire as high a degree of protection as possible. Men have been inoculated thirty and forty times without injury of any sort, and many now undergo the operation each year as the epidemic season approaches.

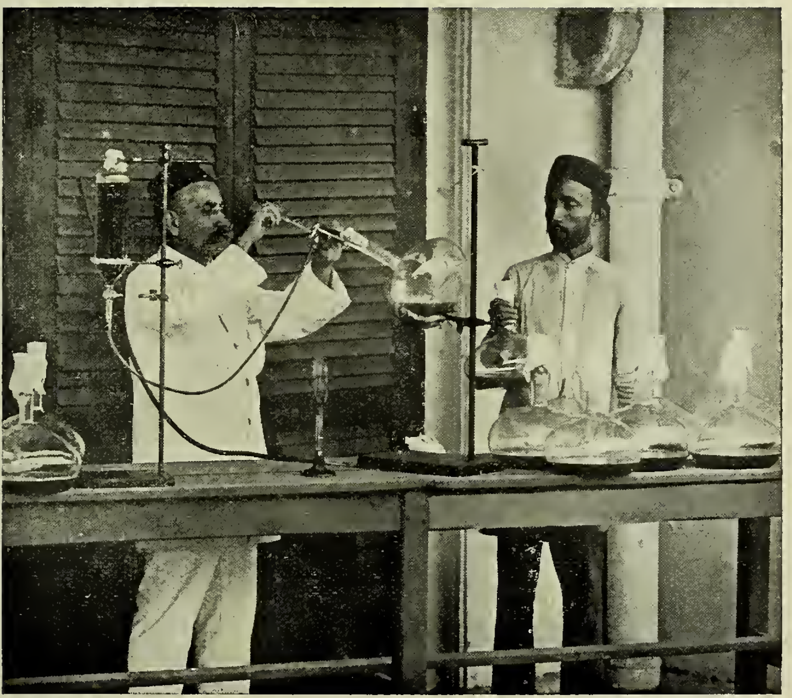
Does Inoculation give rise to any Disease, or does it in any Way affect the Health of those inoculated?

To both of these questions an emphatic answer in the negative can be given. Apart from the fact that a sterile fluid, such as the anti-plague vaccine is, could not possibly give rise to any bacterial disease ; statistics which have been collected prove that inoculation in no way affects the health of those who undergo the operation. The Medical Officers of Prisons have a unique opportunity of watching the inoculated for months and even years after the operation, so that if any ill-effects followed they would certainly discover them. In the large jail at Yeravda 3,000 prisoners were inoculated in 1900. In 1901 some 2,000 more were done, and those remaining in prison from the previous year were re-inoculated. In 1903 about 1,800 more prisoners and in the following year 35 contact cases were inoculated. Out of this total of 6,835 inoculations not a single bad result followed the operation except in three cases—an enlarged gland in the axilla, which disappeared within a week.

Major Jackson, referring to the extensive inoculations which have been carried on in all the jails in the Bombay Presidency, remarks : " Now, if inoculation had the varied and terrible after-effects that its opponents declare, we would naturally expect to find an increased death-rate in those prisons in which inoculation has been steadily resorted to. But we find the contrary." After quoting statistics, the Inspector-General concludes with the following weighty sentence : " These death-rates seem to me to conclusively prove that no ill-effects followed inoculation either by lowering the general vitality or by the production of any specific disease."

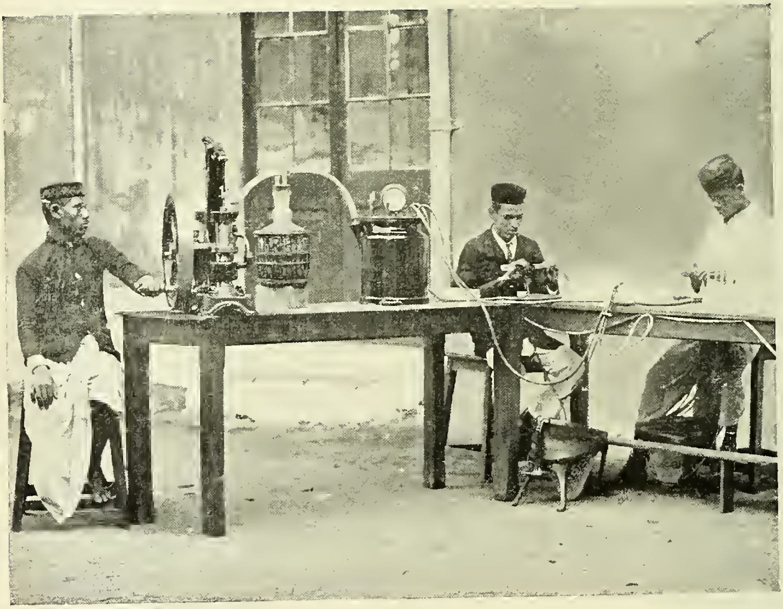
To get further evidence on this subject, two officers from the Laboratory visited the Thana Jail in November 1901. The prisoners were paraded and every alternate man, as they happened to have seated themselves, was inoculated.

Two groups of 238 inoculated and 236 uninoculated were thus obtained, and a minute record of them kept for nearly 30 months. Every fortnight these men were weighed, as this is a well recognised index to the state of health of prisoners. Details as to admission into hospital, the nature of their illness, and its duration and result were also recorded, so that a comprehensive history of each individual during his stay in jail was compiled. It was curious to watch the close equality in all these matters which appeared in the two groups as the



Carbolising the Anti-plague Vaccine.

PLATE VII.



Vacuumising the Bottles.

Plate VIII.

fortnightly records arrived. The following table, which summarises some of the results obtained, is instructive :—

	Inoculated.	Uninoculated.
Number of prisoners on 6th November 1901	238	236
Average weight on 6th November 1901	Lbs. 106·0	Lbs. 108·4
Number of the above remaining in jail on 17th April 1904	79	69
Average weight on 17th April 1904.	Lbs. 108·8	Lbs. 110·3
Average increase of weight ...	,, 2·8	,, 1·9

The Preparation of the Vaccine.

Nature of the Vaccine.

It may interest the readers of this pamphlet to know something of the method adopted for preparing the anti-plague vaccine. Shortly, the vaccine may be described as a culture of the plague bacillus which, after growing in broth for a period of at least six weeks, is sterilised or killed, and to which ·5 per cent. carbolic acid is added. The material is sent out in hermetically sealed glass bottles. Each bottle contains, as a rule, 20 cubic centimetres of the vaccine, and this quantity is sufficient for five full doses.

The Preparation of the Medium in which the Germ is grown.

The broth or soil in which the plague germs are cultivated is manufactured from goat's flesh or wheat flour. To this hydrochloric acid is added and the mixture is placed in large jars for three days surrounded by water kept at a temperature of 70°C or 158°F. The insoluble albumen of the meat or flour is converted during this process into the soluble albuminoid bodies, known as peptones and propeptones. Caustic soda is then added to the acid liquid until it becomes neutral, and common salt is thus formed. The liquid is now diluted, boiled and filtered and placed in large glass flasks which are corked with cotton wool. The flasks are passed into a large steriliser, where they are subjected to saturated steam at a pressure of two atmospheres ; a clear sterile amber-coloured liquid or broth is thus obtained, and this is the soil in which the plague germ is grown.

The Isolation of the Plague Germ.

The plague germ is isolated either from the blood or the bubo of a patient suffering from the disease. It is purified by growing it in test-tubes containing broth jelly, which is made by adding some sea-weed called agar-agar, or "Chini ghas," to the liquid broth. The germ is then thoroughly identified as the plague bacillus by submitting it to a number of tests. Among the chief of these tests is the characteristic appearance known as "Haffkine's stalactites" presented by the growth of the organism in suitably prepared broth. This appearance has been photographed and is reproduced on plate IV.

The Preparation and Sowing of the Seed Material.

The plague germ, which has thus been carefully isolated and identified, is then cultivated in a Pasteur flask for a period of not more than fourteen days. A small quantity of the material contained in the Pasteur flask is transferred to several larger flasks, each containing one litre of the broth. In this way the seed is multiplied. This is effected in the sowing and testing room, a photograph of which is reproduced on plate V.

The Incubation and Development of the Plague Bacilli.

Adjacent to the sowing and testing room is the Incubating room. Here the flasks, which have been sown with the plague germs, are placed in rows on long tables and are allowed to remain there in semi-darkness for a period of at least six weeks. During this period the plague germs multiply enormously, so that the broth, which was clear when brought into the room, soon turns turbid because of the vast increase in the number of plague germs it contains.

Testing the Purity of the Vaccine.

When required for use the flasks are again returned to the sowing and testing room. Here a small sample of the contents of each flask is carefully removed with aseptic precautions and is transferred to a broth jelly tube. After 24 to 48 hours the germs grow upon the surface of this tube. Now, just as the farmer recognises the nature of the crops growing in his fields by their distinctive characters, so the bacteriologist distinguishes the appearances of his crops of germs. If the appearances indicate that plague germs alone are present in the tube, the flask from which the sample was taken is passed on for further manufacture and tests.

Sterilisation of the Vaccine.

Having passed this test, the plague germs contained in the flasks are next killed by being subjected to a temperature of 55°C. or 131°F. for 15 mintues, a process which is effected by submerging the flasks in hot water. The material contained in the flask is now sterile and contains no living organism of any sort.

Carbolising the Vaccine.

To prevent any possibility of any organism growing in the broth after this stage in the manufacture has been reached, carbolic acid is added to the extent of .5 per cent. This addition of carbolic acid is an important step in the manufacture of the vaccine, for it renders the broth an unsuitable medium for the growth of any sort of germ, and therefore ensures that no such disaster as that which took place at Mulkowal in 1903 can ever again occur.

The Preparation of the Bottles in which the Vaccine is despatched.

At this point it is necessary to leave for a moment the consideration of the further treatment of the vaccine and pass on to review the methods adopted for the preparation of the bottles in which the vaccine is despatched. The glass bottles used for this purpose have a peculiar shape, which is illustrated in Plate X.

By means of an air-pump and other apparatus illustrated in Plate VIII, the bottles are vacuumised and sealed in this condition. They are then packed into iron boxes which are placed in large ovens, where they are exposed to a temperature of about 180°C. for three and a half hours. Exposure to this heat is sufficient to destroy any bacteria which may be present in the bottles. The iron boxes, when removed from the ovens, are immediately sealed and the word "sterilised," with the date, is stamped upon them. They are then taken to the decanting room, where the bottles are filled with the sterile carbolised vaccine.

Decanting the Vaccine.

In the decanting room the anti-plague vaccine passes into the hands of the decanters who have been specially trained. They must pass a series of tests in the method of decanting before they are allowed to undertake the routine work of filling the bottles. It is their duty to introduce into the flask, in an aseptic manner, a suitably bent glass tube and connections known as the syphon and filler. This piece of apparatus has previously been sterilised, and is placed beside the decanters in closed zinc boxes, from which they are removed from time to time as required. Within the bulbous metal filler there is a rubber diaphragm and a bent piece of metal tubing, called the "breaker." To fill the bottle, the long bristle-like neck is thrust through the rubber diaphragm, and the point thus impinges upon the breaker. With gentle pressure and a rotatory movement the point of the bottle breaks off within the filler. As soon as this occurs, the fluid vaccine rushes through the syphon into the bottle to replace the vacuum, which, as we have seen, was created in the bottle before it was sterilised. When the flow into the bottle ceases, the long neck is withdrawn from the filler, the rubber diaphragm closes behind the bottle, and so prevents the escape of the fluid contained within the filler. Thus it comes about that the bottles are filled without exposing the fluid to contact with unsterilised air. The broken point is immediately sealed in a flame after withdrawing the bottle from the filler.

Testing the Vaccine for Sterility.

The bottles are now set aside for a week—a period which permits of the multiplication of any germ which might inadvertently have gained entrance to the vaccine during the process of decanting. Two bottles are selected from the number (about 45) which are filled from each flask or "brew", and these are examined to ensure that the brew is sterile. The tests are carried out in two ways—aërobically and anaërobically. By the former method any germs which require the presence of oxygen for their development are discovered, while by the latter method such organisms as the tetanus bacillus, which can grow only in the absence of oxygen, are detected. Should these tests prove satisfactory, the brew is pronounced fit for use.

The Sealing of the Bottles and Retention of a Sample of each in the Laboratory.

The last stage in the process of preparation is now reached. A small portion of the contents of each bottle is driven into the long neck. The neck is then heated in a blow-pipe flame near the shoulder of the bottle ; the glass is thus melted, and the long neck is separated from the body of the bottle. In this operation the bottle and neck are simultaneously hermetically sealed. The neck contains a sample of the vaccine which is sent out in the bottle, and this sample is retained in the Laboratory as an "office copy." All the samples from the same brew are kept in a sheet of corrugated paper in the manner depicted in plate X.

Should any suspicion arise as to the condition of the contents of a bottle, the sample contained in the long neck of the bottle, which has been filed in the Laboratory, can be tested. In this manner not only is the public safeguarded, but the Laboratory is protected against false charges. Although thousands of doses of anti-plague vaccine have now been issued since the above-described improvements in the preparation of the vaccine have been introduced, it has never been proved that a single bottle has been issued from the Laboratory, the contents of which were not sterile.

Precautions taken to avoid Contamination of the Vaccine by the Operator.

While in this way it is now possible to ensure that none but sterile anti-plague vaccine leaves the Laboratory, the chances of the vaccine becoming contaminated in the hands of even an unskilled operator have been greatly minimised, if not completely abolished.

In the first place, the new type of bottle is better adapted for opening in an aseptic manner than the old bottle with a rubber cork was. There is no cork to drop on the ground and contaminate the vaccine by being reinserted in the bottle. The bottle cannot be opened by accident or from curiosity without first sterilising the neck. When it is once opened, it cannot be closed again, and there is, therefore, no temptation to keep any of the fluid for another day. The pointed end is heated in a flame till it becomes sterile and hot. Then with a jerk the cold fluid in the bottle is made to impinge on the hot glass, which, in consequence, cracks, and the bottle is thus readily opened.

In the second place, the syringe is sterilised by using hot oil or vaseline at a temperature of 160° C. A cheap and effective apparatus has been designed for this purpose, and is supplied to all who desire to use it. A picture of Dr. Kapadia's lamp, as this apparatus is called, is illustrated in plate XII.

Directions for sterilising the syringe will be found in another part of this pamphlet.

Again, special classes have been instituted for the training of men in the methods of carrying out inoculation, and the anti-plague vaccine is only supplied to those who are certified as competent to carry out the simple operation.

How to indent for the Anti-Plague Vaccine.

No special indent forms are required, but the following rules published by the Government of Bombay in Government Resolution, General Department (Plague), No. 1567-P. of 16th November 1907, must be complied with :—

Rules for the issue of Plague Prophylactic from the Bombay Bacteriological Laboratory, Parel, Bombay.

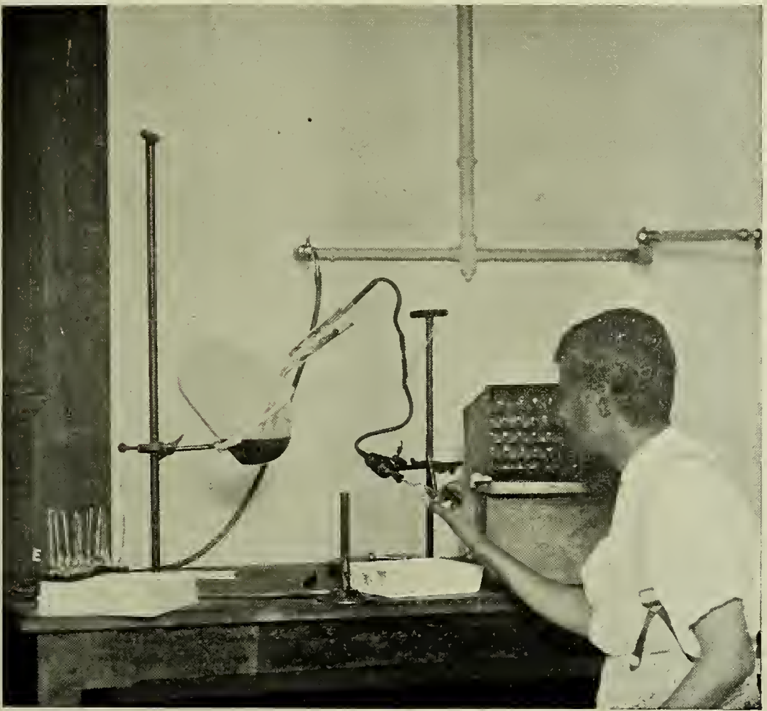
In India.

1. Applications received from Government or other public officials and Medical Officers, of whose fitness to use the prophylactic there is no doubt, and from practitioners who have already been once supplied on the recommendation of Civil or Medical Authorities, will be complied with at once.

2. Applications from medical practitioners who have not been supplied before must be sent through the Chief Civil Authority, or Medical Officer of the place where they reside. In the event of the application being supported, it will be complied with. Subsequent applications may be submitted direct to the Laboratory, when they will be dealt with in the ordinary course, the applicant not being required to submit his application again through the Civil or Medical Authority.

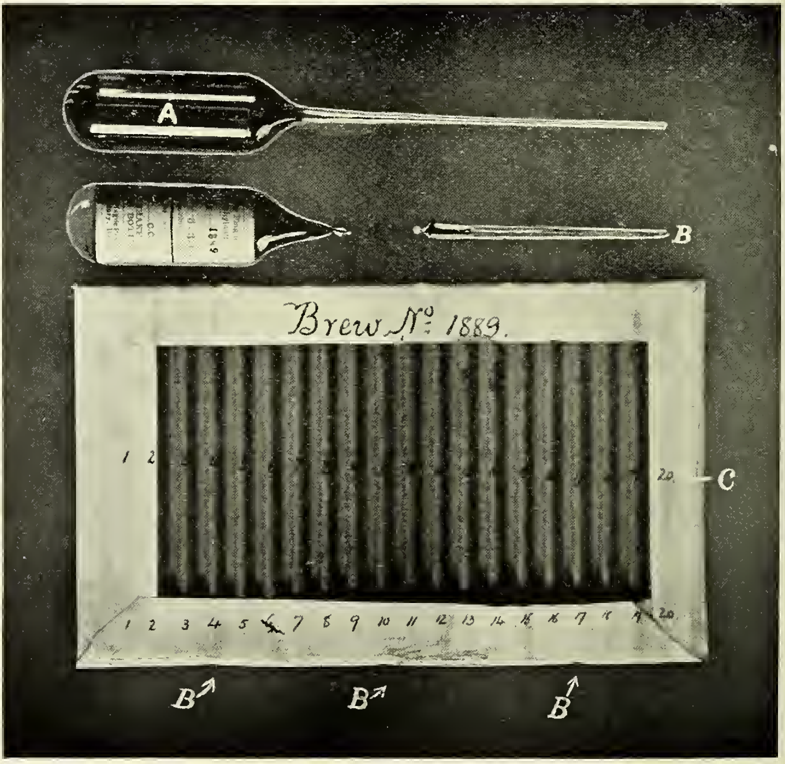
3. Applications from firms of chemists or private individuals not medical men cannot be accepted. The Resident Physician of a firm of chemists may be supplied with the prophylactic, and the requisition will be dealt with as a case of first application from a private medical practitioner. In this case the prophylactic will be supplied on the distinct understanding that it is required for *bonâ fide* personal use, *e.g.*, inoculating his staff or patients, &c. In no circumstances is the Resident Physician authorised to allow the prophylactic supplied to him to be used by anyone else.

4. Local Governments, Local Boards or Municipalities desiring that a stock of prophylactic should be available for use in emergencies should arrange for the local Medical Store-



Decanting the Vaccine.

PLATE IX.



Shows the Shape of the Bottle and the Method of filing Samples.

PLATE X.

keeper, or Civil Surgeon, or Health Officer, to be supplied accordingly. Only medical men are to be entrusted with the custody of the prophylactic.

5. A charge of ½ anna per dose is made for the anti-plague vaccine supplied to applicants outside the Bombay Presidency, as well as independent Native States within the Presidency. There will be, in addition, a charge of 1 anna 3 pies to defray the cost of each bottle, which contains, as a rule, 5 doses, besides the charges for packing and freight. In the Bombay Presidency no charge is made to applicants for anti-plague vaccine, except the cost of bottles, packing and freight.

Out of India.

6. *British Colonial Governments.*—Applications from British Colonial Governments will be complied with at once without any previous reference to Government. The despatch of such consignments will be at once reported to Government for information.

7. Applications from British Consulates will be complied with without any previous reference being made to Government. A report will be made as above.

8. Applications from Foreign Consulates and Governments must in all cases have received the previous sanction of Government before being complied with, subsequent intimation being also sent of the actual despatch.

9. Applications from medical practitioners not in the service of the British Government, including medical missionaries and foreigners in the employ of Foreign Governments or Consulates, will not be complied with unless supported by the British Consul of the place where the applicant is a resident.

10. The supplies to countries outside India are subject to the condition that Indian requirements are met first. Applicants for anti-plague vaccine out of India will be charged annas 2 per dose, besides 1 anna 3 pies, the cost of each bottle containing five doses, packing and freight being extra.

The Storage of the Vaccine.

Officers indenting for a supply of vaccine should invariably specify the number of doses required, not the number of bottles. The bottles should be stored in a cool dark place, and under these circumstances the material may be expected to retain its full efficiency for at least 18 months. After this period the old vaccine may be destroyed and a fresh supply will be sent in exchange free of charge, except for cost of bottles, packing and freight, on intimation being received of the amount so destroyed. Indents for fresh vaccine to replace old material in stock should have this fact noted on them to prevent error in preparing bills.

A supply of fresh vaccine, to Colonial and Foreign Governments or other bodies outside India, which is to take the place of vaccine which has deteriorated through lapse of time, will be charged for at the same rate as an original supply.

Equipment for an Inoculator.

The following complete equipment for an Inoculator is generally required :—

	Rs.	a.	p.
Some doses of anti-plague vaccine			
Two 20 c.c. Roux syringes complete @ Rs. 17 each ..	34	0	0
6 extra needles @ Re. 1 each	6	0	0
6 spare rubber plungers @ ans. 6 each	2	4	0
26 spare glass barrels @ ans. 11 each	1	6	0
6 spare pairs of washers @ ans. 2 each	0	12	0
1 Kapadia's sterilising apparatus complete with lamp, stand, aluminium dish and thermometer graduated in degrees centigrade	2	13	9
1 spare thermometer	1	4	0
1 pair of pliers	0	12	0
1 pair of dissecting forceps	1	2	0
1 aluminium dish for carbolic lotion	0	4	0
1 and one-half ounce aluminium measure	„	12	„
1 20-ounce bottle for 1 in 20 carbolic lotion	0	3	0
1 bottle containing 1 lb. methylated spirit	0	9	4
1 bottle containing 1 lb. pure carbolic acid	1	8	0
1 tin containing 9 ounces of vaseline	0	6	0
2 packets containing ½ lb. absorbent cotton in each...	0	12	0
2 towels	1	6	0
1 cake of soap	0	2	0
1 box of matches	0	0	3
1 enamel basin	0	8	0
2 certificate books	1	4	0
2 copying ink pencils @ ans. 10 per dozen	0	1	8
2 sheets carbon paper @ ans. 1 each	0	2	0
1 painted deal wood box with padlock and keys complete for packing these articles	2	8	0
This complete equipment can be supplied properly packed and in portable form, cost exclusive of anti-plague vaccine for	60	12	0

The whole equipment or any separate article in this list can be supplied at the prices quoted above.

Repairs.

Minor repairs to syringes are effected at the Laboratory free of charge.

Disposal of used Bottles, &c.

The empty bottles, boxes and material used for packing are not to be returned to the Laboratory. Those supplied to Government officials should be sold locally to the best advantage and the proceeds credited to Government in the local treasury in the same way as boxes and packing from the Medical Stores are dealt with.

Telegrams should be addressed "RESEARCH," and parcels, if sent by G. I. P. Railway, to be booked to Parel ; if sent by B. B. & C. I. Railway, to Elphinstone Road Station.

Letters should be addressed to—

The Director,
Bombay Bacteriological Laboratory,
Box 12. Parel, Bombay.

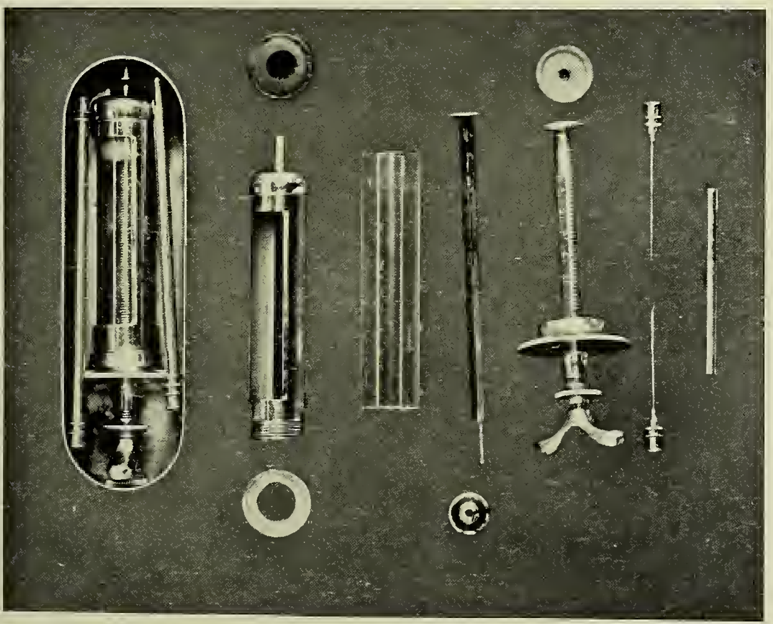
Methods for effecting Payment for Articles supplied.

The bills preferred by this Laboratory for articles supplied are of two kinds :—

(1) Adjustment bills.
(2) Cash bills.

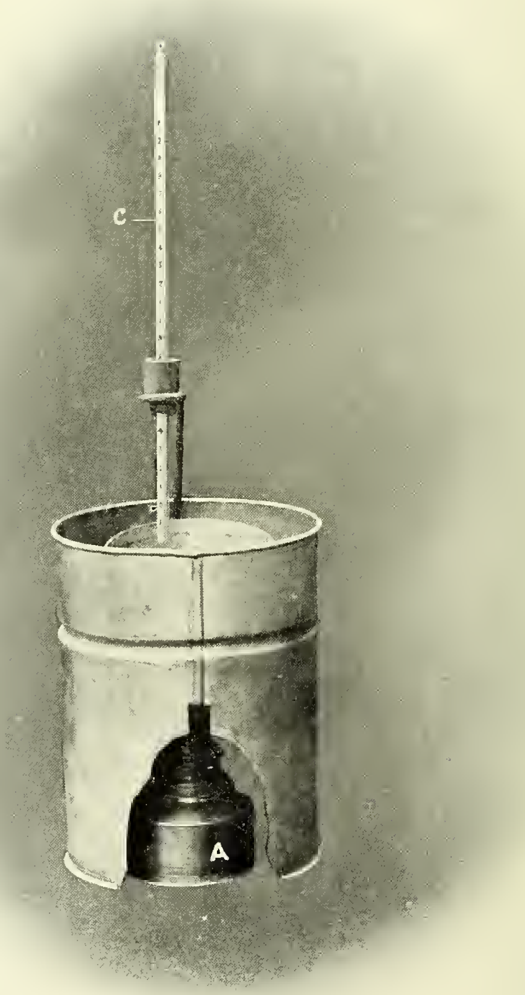
(1) Bills for supplies furnished to Government officials are sent on adjustment forms in duplicate. The original copy, together with the receipt at the foot of the duplicate copy, should be signed by the receiving officer and returned to the Laboratory on receipt of the goods. The duplicate copy of the bill may be retained by the indenting officer. Cash should never be sent in payment of these bills. The money will be recovered by book-adjustment made by the Accountant-General, Bombay.

(2) Cash bills are presented to private practitioners, municipalities and others who have no book-adjustment with the Accountant-General. The bills should be adjusted either by money order or cheque. Government officials, when ordering vaccine or other materials on behalf of municipalities or others, should invariably state for whom the material is required, so that the proper bills may be despatched.



The Syringe complete and in separate parts.

PLATE XI.



Kapalia's Sterilising Lamp.

PLATE XII.

How to proceed to carry out Inoculations.

The influential leaders of the people, heads of castes, teachers of religion and village headmen, should be approached. The advantages of inoculation should be explained to them and their assistance solicited to persuade their less educated brothers to protect themselves from plague by inoculation. A number of people, 100 or more, should be assembled with their leaders in a local temple, courtyard, school-house, or other suitable enclosure. Those who volunteer should be inoculated, while the remainder of the people look on. Nobody should be allowed to leave the meeting until all who are willing have been inoculated. The onlooking waiverers, having seen how simple and painless the operation is, frequently come forward and follow the example of their friends. If the meeting is allowed to disperse before all who are willing are inoculated, some will leave with exaggerated ideas of the painfulness of the operation. It is always a disadvantage to inoculate small numbers of people at a time.

The Symptoms produced by Inoculation.

The symptoms caused by inoculation commence, as a rule, in 3 to 5 hours, and consist chiefly of swelling and pain at the seat of inoculation and of a rise of temperature. Pain is much increased by the taking of alcohol, or on movement of the part, so this had better be avoided for 36 hours after operation. The fever is accompanied by the general discomfort usual to this condition, and no treatment of symptoms is required beyond taking some rest. General symptoms subside after 24 to 36 hours as a rule, but if not, a purge will give relief. The pain at the seat of inoculation lasts for 3 or 4 days, disappearing gradually, but a painless induration may remain for some little time. The fluid acts differently on various people, and a uniform reaction cannot be obtained, fever being almost absent in some cases. It is not known whether there is any relation between the presence of high temperature after inoculation and the degree of protection acquired thereafter by the individual, so an absence of reaction does not mean that the inoculation has not "taken," as would be said in similar circumstances after vaccination for small-pox.

What Dose of Vaccine to use under varying Conditions?

The usual dose for an adult man is 4 cubic centimetres (1 c.c. —17 minims), but the labels on the bottles must always be consulted on this point.

The following table shows the doses to be given to persons in good health at various ages :—

If the dose marked on the bottles is 4 c.c. then—

To individuals	of from	10 days to 1 year	give	0·2 c.c. or 1/25	of full dose.
,,	,,	1 to 2 years	,,	0·8 c.c. or 1/5	,,
,,	,,	2 to 5 years	,,	1·6 c.c. or 2/5	,,
,,	,,	6 to 11 years	,,	2·4 c.c. or 3/5	,,
,,	,,	12 to 15 years	,,	3·2 c.c. or 4/5	,,
,,	,,	16 to 50 years	,,	4·0 c.c. or full dose.	

If the dose marked on the bottle is other than 4 c.c., the amount to be given at various ages is to be calculated in the same proportion as above.

Children stand the treatment well, and no fear need be felt in giving the doses above mentioned.

Persons over 50 years of age should get $\frac{1}{10}$th less for each decade above that age.

Women of all ages over 14 years should get $\frac{1}{10}$th less than men of corresponding ages.

Pregnant women may be inoculated up to the 7th month inclusive, without making any special reduction of dose. After the 7th month the dose should be given in two instalments separated by an interval of a week or so. Miscarriage has never been known to result from inoculation ; and the danger from plague to lying-in women is so great that *a special effort should be made to induce pregnant women to be inoculated.*

Persons suffering from fever should not be inoculated till 48 hours have elapsed after the fever has entirely subsided.

With the exception of persons suffering from fever and those obviously ill from any cause, all can be inoculated. No harm has ever been known to be produced by inoculation in the case of persons suffering from chronic diseases as phthisis, rheumatism, diabetes, etc.

How to sterilise and fill the Syringe.

The first step in the operation of inoculation is to sterilise the syringe and needle. For this purpose Kapadia's sterilising apparatus is conveniently used. The apparatus consists of a pot for heating oil or vaseline. The pot is placed on a block tin stand, which at the same time serves to protect the flame of a spirit lamp placed beneath from draughts of air. Methylated spirit is used in the lamp. *Never pour in spirit while the lamp is alight.*

The oil for use in the cup may be olive, cocoanut, or any similar oil which has not an acid reaction, but vaseline is very convenient, as it becomes solid when cold, and does not spill when packed for travelling.

Fit up the sterilising apparatus and light the spirit lamp. See that the thermometer is in good order and adjust it properly in the vaseline. Then take out the syringes and needles.

1. See that the needles are sharp, clean and patent. If these points are attended to, work is greatly facilitated, and the operation is much less painful. Place the needles in the vaseline.

2. See that the syringe is airtight. This is done by placing a finger over the nozzle and at the same time pushing home the piston ; if the syringe is working properly, resistance will be felt to the pressure against the piston and it will slip back when released, provided the finger has been retained firmly over the nozzle. The tightness of the plunger in the barrel can be regulated by the screw in the handle.

3. When the temperature of the vaseline has reached 90° C. fill up the syringe with the heated vaseline and empty it again into the pot. This is done to get rid of moisture in the syringe; at temperatures above 100° C. any moisture is immediately converted into steam, and this causes the vaseline to crackle and splash and may, perhaps, fracture or burst the glass barrel.

4. Now wait till the temperature has reached 160° C. Then completely fill and empty the syringe twice with the hot vaseline. A temperature higher than 160° C. injures the india-rubber plunger, and a temperature lower than 160° C. is not so efficient in effecting sterilisation.

5. With the dissecting forceps fish out a needle, which has been lying in the hot vaseline, and adjust it firmly to the nozzle of the syringe by means of the pliers, which should, previous to grasping the needle, have been dipped momentarily in the hot vaseline.

6. Now for the third time draw up and eject the hot vaseline from the syringe ; on this occasion with the needle in position. The syringe may now be carefully laid on one side preferably supported on the lid of the syringe box and allowed to cool. The needle should not be allowed to come in contact with any article or surface.

7. A bottle of anti-plague is then taken in hand. The number of the brew and the number of the bottle and dose to be used is noted.

Examine the neck carefully for any cracks or flaws. By handling the bottle in the same way that the index of a clinical thermometer is shaken down, leakage, through such cracks, may be detected. Faulty bottles should invariably be re ected, and the contents thrown out.

The bottle should then be well shaken, so as thoroughly to mix the sediment, which will be seen at the bottom of the bottle, with the fluid. *The sediment consists of the dead bacteria, and is an essential part of the vaccine.*

8. To open the bottle, hold the neck in a flame, turning the bottle round all the time so as to sterilise every part of

the neck. When the glass is sufficiently heated, jerk up a little of the fluid, and the neck will crack. The tip may then be knocked off by a sharp blow from a pair of sterilised forceps.

9. Now take up the syringe, draw into it a small quantity of hot vaseline, and again eject it. While the needle is still hot, draw into the syringe two or three cubic centimetres of the anti-plague vaccine. Place the bottle on its side on the table. Then draw out the piston of the syringe to its full extent, and shake up the small quantity of the vaccine within the barrel of the syringe. Eject the contents of the syringe. This is done to get rid of some of the excess of vaseline which adheres to the interior of the syringe.

10. Again dip the needle in the hot vaseline, pass the point of the bottle through the flame, and then fill up the syringe. Get rid of excess of air by adjusting the piston. Note the graduation marks on the shaft of the piston, and read off four marks counting from the outside of the barrel of the syringe. Screw up the discs (to be found at the handle end of the shaft of the piston) to the point noted. The syringe is now ready to deliver 4 cubic centimetres or one dose of the vaccine.

How to carry out the Operation of Inoculation?

The most convenient site for the operation is the back of the left upper arm about midway between shoulder and elbow. The skin at this spot should be well scrubbed with 5 per cent. carbolic lotion (1 in 20). The skin being then puckered up between the thumb and fingers of the left hand, the needle should be pushed through the skin in a sloping direction, more or less parallel to the surface, carefully avoiding the big vessels and not penetrating the muscles, but taking care to enter the subcutaneous tissue. Then slowly inject the dose. Withdraw the needle of the syringe, and apply for a few seconds a pad of cotton wool dipped in 1 in 20 carbolic lotion.

The next patient is operated on in the same way. The needle of the syringe is first dipped momentarily in the hot vaseline, which is kept at hand at a temperature of 160° C.

The screw on the shaft of the piston is again adjusted to four spaces from the barrel of the syringe, each space being equal to one cubic centimetre. The arm of the patient is scrubbed with 1 in 20 carbolic lotion. A drop or two of the vaccine should be ejected from the syringe to get rid of any oil or vaseline within the needle. The needle is then inserted, and the dose injected.

Between each operation the needle of the syringe is sterilised by dipping it into the hot vaseline.

As only sterile fluid has been introduced into the syringe, if proper precautions have been taken to sterilise the needle between each operation, the interior of the syringe need not be sterilised between the filling of each bottle. At the close of the operations the syringe should be thoroughly washed out with 1 in 20 carbolic lotion, and the needles should be covered with vaseline.

Other Work carried out at the Laboratory.

In addition to the preparation of anti-plague vaccine, the Laboratory functions as a Pathological Diagnosis Institute. Pathological specimens of all sorts are examined and reported on. Slide preparations made from blood, ulcers, etc., are stained and examined, serum sent in blood capsules is tested, sections from tumours are prepared, diseases occurring in animals, such as plague in rats, rabies in dogs, anthrax in cattle, are reported on. Mosquitos, fleas, biting flies and other insects are examined and identified. Snakes are gladly received and identified. Scientific apparatus, chemicals, stains, sera, etc., according to the subjoined list, are supplied at the rates specified.

STAINS IN SOLUTION.

						Rs.	a.	p.
Bismarck Brown,	solution,	aqueous	per	100	c.c.	1	0	0
,, ,,	,,	alcoholic	,,	,,	,,	3	0	0
Carbol Fuchsine	,,	... ...	,,	,,	,,	1	0	0
,, Thionin	,,	... ...	,,	,,	,,	1	6	0
Gabbet's Blue	,,	for tubercle bacilli ...	,,	,,	,,	1	0	0
Gentian Violet	,,	alcoholic saturated ...	,,	10	,,	0	5	3
Giemsa's	,,	... ...	,,	50	,,	1	11	0
Gr~~u~~am's Iodine	,,	... ...	,,	100	,,	1	0	0
Leishman's Stain	,,	... ...	,,	50	,,	1	6	0
Methylene Blue Stock	solution	for Romanowski...	,,	100	,,	1	2	0
Eosine ,, ,,	,,	,, ,, ...	,,	,,	,,	0	12	0

DRY STAINS.

								Rs.	a.	p.
Fuchsine ...	...	powder	in	5	grammes	bottle	...	0	8	0
Gentian Violet	...	,,	,,	10	,,	,,	...	1	8	0
Leishman's Stain	...	,,	,,	5	,,	,,	...	5	12	0
Bismarck Brown	...	,,	,,	5	,,	,,	...	0	6	0
Dahlia ...	...	,,	,,	5	,,	,,	...	0	10	0
Eosine Extra B.A.	...	,,	,,	5	,,	,,	...	0	10	0
Methylene Blue Med.	pure	,,	,,	10	,,	,,	...	1	8	0
Neutral Red	...	,,	,,	5	,,	,,	...	2	0	0

GLASSWARE.

		Rs.	a.	p
Micro slides, quality No. 1	per gross	8	0	0
,, ,, hollow ground	,, doz.	1	8	0
,, ,, cover glasses	,, gross	6	0	0
Test tubes without rims	,, doz.	0	12	0
Flasks without rims, 100 c.c. capacity	,, each	0	4	0
,, ,, ,, 250 c.c. ,,	,, ,,	0	5	0
,, ,, ,, 500 c.c. ,,	,, ,,	0	6	0
Drop bottles	,, ,,	0	8	0
Staining Well with lid	,, ,,	1	2	0
Watch glasses	,, doz.	0	12	0
Graduated pipette, 1 c.c. capacity	,, each	0	12	0
Petri dishes in pairs, 2½ to 3 inches diameter	per each pair	0	10	0
Extra W.M. stoppered bottle for slides	per each	0	12	0
,, ,, ,, ,, ,, cover glasses	,,	0	6	0
Stoppered bottles N.M., 4 oz. capacity	,,	0	3	6
,, ,, ,, 8 ,, ,,	,,	0	4	6
Blood capsules	per doz.	0	4	0
Sedimentation tubes	,,	0	4	0
Specimen tubes with corks for mosquitos	,,	0	12	0
Glass pipettes, long	,,	0	8	0
,, tubing and rod	per lb.	1	0	0

INSTRUMENTS.

Copper stand for warm staining	per each	5	0	0
Surgical needles, straight	per doz.	1	8	0
Platinum needle	per each	0	12	0
Test tubes brush	,,	0	2	0
Cornet forceps (cover slip holder)	,,	1	4	0
Scissors, straight or bent or flat	per pair	2	0	0
Mouse tongs	per each	6	8	0
Pencil for writing on glass (blue, red or yellow)	,,	0	6	0
India-rubber Teats	per doz.	1	4	0
Sterile swab for diphtheria or other purposes	per each	0	3	0
Filter paper, 11 c. m., in packets of 100	per 100	1	0	0
,, ,, 15 c. m. ,, ,, ,, ,,	,, ,,	1	2	0
,, ,, chardin	per doz.	1	8	0

CULTURES AND EMULSIONS.

Capsule of Emulsion for Typhoid and Malta fever diagnosis	per each	1	0	0
Culture of Typhoid and other organisms	,, ,,	0	10	0
Plague Culture Bouillon	,, ,,	1	0	0
Agar Tubes for Cultures	,, doz.	3	0	0
Broth Tubes, hermetically sealed	,, ,,	3	0	0

SERA.

		Rs.	a.	p.
Tetanus Antitoxin, Fluid	per each bottle of c.c.	3	0	0
,, ,, Dry	,, ,, ,, ,, 1 grm	3	0	0
Antistreptococcic Serum	,, ,, ,, ,, 10 c.c.	1	14	0
Anti-Dysenteric ,,	,, ,, ,, ,, 20 c.c.	3	12	0
Veterinary Tuberculin	,, ,, ,, ,, 3 c.c.	0	12	0
,, Mallein	,, ,, ,, ,, 3 c.c.	0	12	0

CHEMICALS.

		Rs.	a.	p.
Acid, Acetic	per oz.	0	2	0
Alcohol, Absolute	,, 8 ,,	1	10	0
,, Methylated	,, lb.	0	8	0
,, Methyl Merk's Puriss	,, ,,	2	4	0
Cedarwood Oil for immersion	,, oz.	1	0	0
Oil of Cloves	,, ,,	0	8	0
Canada Balsam in Xylol	,, ,,	0	8	0
Dulcite	,, lb.	38	0	0
Formalin	,, ,,	2	0	0
Grubler's Peptone	,, ,,	36	0	0
Glycerine Pure	,, oz.	0	8	0
Lactose	,, ,,	0	4	0
Levulose	,, ,,	1	4	0
Litmus Powder	,, lb.	1	4	0
,, Granular	,, ,,	1	0	0
Lysol	,, ,,	1	0	0
Sodium Taurocholate	,, ,,	8	0	0
Xylol	,, 8 oz.	1	4	0

Other stains and apparatus can be obtained on giving two months' notice.

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